

pending Application No. 10/656,561. The Examiner argues that while the conflicting claims are not identical, they are not patentably distinct from each other because the claimed ranges of the Sn-Bi-In alloy are overlapping or close to the ranges of the alloy in the co-pending applications. The Examiner concludes that it would have been obvious to one having ordinary skill in the fuse art at the time of the invention to adjust the ranges for ternary alloys as claimed in the co-pending applications in order to arrive at the presently claimed ranges. While not agreeing with the Examiner's conclusions, Applicant files herewith a Terminal Disclaimer and Statement of Common Ownership with respect to the '780 and '561 applications. Accordingly, withdrawal of the double patenting rejections is respectfully requested.

Prior Art Rejections

In the present Office Action, the Examiner has also rejected claims 1, 3, 5, 51, 53, 55, and 57 under 35 U.S.C. § 103(a) as being unpatentable over JP 3-236130 ("JP '130") or JP 59-8229 ("JP '229"). Regarding JP '130, the Examiner argues that a fuse element which has an alloy composition of 48 to 52% In, 44 to 48% Sn, and 2 to 6% Bi is taught in example V. The Examiner concludes that the presently claimed ranges are overlapping or close to the ranges in the JP '130 alloy.

The Examiner also argues that JP '229 discloses a fuse element which has an alloy composition of 51 to 53% In, 42 to 44% Sn, and 4 to 6% Bi, and concludes that the presently claimed ranges are overlapping or close to the JP '229 ranges. Therefore, the Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to select the claimed ranges for ternary In-Sn-Bi alloys since a case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art or are close enough that one skilled in the art would have expected them to have the same properties.

Regarding claim 5, the Examiner argues that the fuse elements of the prior art inherently contains inevitable impurities. Finally, regarding claims 51, 53, 55 and 57, the Examiner argues that both JP '130 and JP '229 teach that fuse elements are connected between a pair of lead conductors. Applicant respectfully traverses these rejections as follows.

Initially, Applicant respectfully traverses the rejections of claims 55 and 57. Since these claims depend on allowable claims 7 and 9, respectively, they should also be allowable for the same reasons as the allowable claims. Withdrawal of the rejection of claims 55 and 57 is respectfully requested.

Applicant further notes that the alloys in the newly cited prior art references, JP '130 and JP '229, are no closer to the presently claimed alloys than those taught by previously cited JP '724, and thus the newly cited references are at best merely cumulative prior art. The elemental ranges of Sn, In and Bi in the presently claimed alloy, as well as those taught by JP '724, JP '130, and JP '229 are shown in the following Table for convenience.

**Comparison of Claimed and Cited Prior Art Alloys**

	Percentage Sn	Percentage In	Percentage Bi
<b>presently claimed alloy</b>	<b>25 to 44</b>	<b>55 to 74</b>	<b>1 to 20</b>
JP '724 (already overcome)	40 to 46	42 to 53	7 to 12
JP '130	44 to 48	48 to 52	2 to 6
JP '229	42 to 44	51 to 53	4 to 6

Since the rejection based on JP '724 has been withdrawn, it is submitted that the present rejections based on JP '130 and JP '229 should be similarly withdrawn. Applicant previously argued that the presently claimed amount of In, 55 to 74%, does not overlap with the amount of In taught by JP '724 of 42 to 53%, and that it would not have been obvious to increase the amount of In in the JP '724 alloy to within the claimed range. The maximum amounts of In taught by JP '130 and JP '229 (52% and 53%, respectively) are less than or equal to the maximum amount of In taught by JP '724 (53%). Therefore, since the Examiner previously acknowledged that it would not have been obvious to increase the amount of In in the JP '724 alloy from 53% to the claimed 55 to 74%, Applicant submits that rejections based on JP '130 and JP '229 are not appropriate. Applicant's more detailed comments in response to the rejections follow.

As previously explained on the record, the present invention is directed to an alloy type thermal fuse and a fuse element containing a ternary alloy composition of 55 to 74 % In, 25 to 44 % Sn, and 1 to 20% Bi. Alloy type thermal fuses and fuse elements having the claimed elemental compositions were developed by Applicant as a result of intensive study in order to provide a fuse having a narrow operating temperature range and excellent overload and dielectric breakdown characteristics.

The Examiner argues that the claimed ranges are overlapping or close to the ranges taught by JP '229 and JP '130. Although the ranges *per se* of two of the elemental components (Sn and Bi) indeed overlap or touch the prior art ranges, the overall alloy compositions do not overlap, as demonstrated in the liquidus projection diagram attached hereto as Appendix 1.

A liquidus projection diagram is a graphical representation of the elemental composition of a ternary alloy which portrays the concentrations of all three components at one time. Since the concentrations of all three components are critical, it is easier and more accurate to compare the liquidus projection diagrams than the numerical ranges individually. Thus, a liquidus projection diagram (which graphically represents the claimed composition) is a proper way to demonstrate that the claimed and prior art compositions as a whole do not overlap.

In a ternary alloy, the concentrations of all of the components are critical. In this case, the concentration of the third elemental component (In), which does not overlap with that of either JP '130 or JP '229, results in overall compositions which do not overlap with the presently claimed alloy. Thus, since the overall compositions themselves do not overlap, the claimed and prior art alloys would not have been expected to have the same properties and the Examiner's unsubstantiated assertion to the contrary is incorrect.

Additionally, the Examiner has not demonstrated, why, based on JP '130 or JP '229, one would have been motivated to modify the elemental concentrations (and in particular the concentration of In) to arrive at the present invention.

According to MPEP 2142, there must be some suggestion or motivation, either in the reference itself or in the knowledge generally available to one of ordinary skill in the art, to modify the reference, a reasonable expectation of success, and the prior art reference must teach or suggest all of the claim limitations. The teaching or suggestion to make the modification and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. No such teaching or suggestion is found in JP '130 or JP '229 as follows.

In order to arrive at the claimed In concentration from that recited in JP '130, one skilled in the art would have had to, while routinely experimenting with the JP '130 alloy, increase the concentration of In from the JP '130 range of 48-52% to the claimed range of 55-74%. This increase would have necessitated a reduction in the concentration of at least one of the other elements, such as to 1% Bi, 44% Sn or to 2% Bi, 43% Sn (below the recited ranges of Bi and Sn, respectively). However, while the broad alloy of JP '130 contains 48-52% In, the preferred In concentration is 50% (see attached English translation of JP '130, page 11, Ex. 26-30), which is

in the middle of the JP '130 range. Similarly, the preferred Bi and Sn concentrations taught by JP '130 are 4% and 46%, respectively, which are also in the middle of the JP '130 ranges. There is no suggestion in JP '130 that the alloy should be modified to increase the In concentration to 55-74% (above the recited range) and thus decrease the Bi and/or Sn concentrations to below the recited ranges, since concentrations of all three element are preferably in the middle of the recited ranges.

Similarly, in order to arrive at the claimed In concentration from that recited in JP '229, one skilled in the art would have had to, while routinely experimenting with the JP '229 alloy, increase the concentration of In from the JP '229 range of 51-53% to the claimed range of 55-74%. This increase would have necessitated a reduction in the concentration of at least one of the other elements, such as to 3% Bi, 42% Sn or to 4% Bi, 41% Sn (below the recited ranges of Bi and Sn, respectively). However, while the broad alloy of JP '229 contains 51-53% In, the preferred In concentration is 52% (see attached English translation of JP '229, page 5), which is in the middle of the JP '229 range. The preferred Bi and Sn concentrations are also in the middle of the recited ranges, 5% and 43%, respectively. There is no suggestion in JP '130 that the alloy should be modified to increase the In concentration to 55-74% (above the recited range) and thus decrease the Bi and/or Sn concentrations to below the recited ranges, since concentrations of all three element are preferably in the middle of the recited ranges. Since the Examiner has not showed a motivation to vary the prior art concentrations in order to arrive at the claimed concentrations, the Examiner has not established a *prima facie* case of obviousness.

The MPEP states that differences in concentrations will not support the patentability of subject matter encompassed by the prior art unless there is evidence that concentrations or temperature is critical. In the present case, the concentration of the component elements are indeed critical to the resulting alloy. As previously explained on the record, it is taught in the Background Section of the present application that in fuse elements having alloy compositions with a solid-liquid coexisting region (between the solidus and liquidus temperatures), there is a possibility that the fuse element will be fused off at an uncertain temperature in this region. A wide coexistence region thus results in a wide operating temperature range of the fuse. Conventionally, in order to reduce this dispersion of operating temperature, an alloy having a narrow solid-liquid coexistence region, and ideally a eutectic composition, is utilized so that the fuse element fuses off at approximately the liquidus temperature (which is equal to the solidus temperature in a eutectic composition).

A variety of ternary Sn, In, Bi alloys are known. As shown in the liquid phase surface diagram in Appendix 1, these alloys have a binary eutectic point at 52In-48Sn (point E1) and a ternary eutectic point (point E2) at 21Sn-48In-31Bi. The binary eutectic curve which elongates from the binary eutectic point toward the ternary eutectic point passes through a region having 24-47% Sn, 50-47% In, and 0-28% Bi. Alloy compositions in regions separated from the binary eutectic curve have wider solid-liquid coexistence regions, which may possibly widen an indefinite region of temperatures at which the fuse element fuses off and also increase the dispersion of the operating temperature of the thermal fuse. Accordingly, this region has not traditionally been investigated for suppressing the dispersion of operating temperature range by narrowing the solid-liquid coexistence region.

However, by studying a variety of Bi-Sn-In alloys having different compositions and measuring the DSC (differential scanning calorimetry) profiles thereof, Applicant has surprisingly found that when an alloy composition in a specific region which is separated from the binary eutectic curve is used as a fuse element, the resulting fuse element can be concentrically fused off in the vicinity of the maximum endothermic peak, and excellent overload and dielectric breakdown characteristics are thus obtained. Applicant has thus discovered a specific ternary In-Sn-Bi alloy composition, usable for a fuse element, which is suitable for environmental conservation and which provides excellent overload and dielectric breakdown characteristics and a narrow operating temperature range.

The alloy composition in this region, which is separated from the binary eutectic curve, has a wide liquid coexistence region and a single maximum endothermic peak. Accordingly, the dispersion of the operating temperature of the alloy thermal fuse may be controlled. Moreover, in the alloy composition, the total amount of In and Sn, which have a relatively smaller surface tension, is larger than the amount of Bi, which has a larger surface tension. Therefore, the wettability of the solid-liquid coexisting at the maximum endothermic peak is sufficiently improved even before the completion of liquidification, so that spheroid diversion of the thermal fuse element can be performed in the vicinity of the maximum endothermic peak. Consequently, the dispersion of the operating temperature of the thermal fuse can be reduced (and set to be within a range of  $\pm 5^{\circ}\text{C}$ ). The holding temperature of such thermal fuses ( $20^{\circ}\text{C}$  less than the operating temperature) may be less than or equal to the solidus temperature, which is desirable. Further, due to the relatively large percentages of In and Sn in the alloys, fuse elements having sufficient ductility to draw into thin wires, such as 200 to 300  $\mu\text{m}\phi$ , can be achieved.

Applicant has further found favorable results from utilization of a fuse element having the claimed alloy composition which is in a range having a wide solid-liquid coexistence region and is separated from the peripheral region of the binary eutectic curve whose solid-liquid coexistence region is narrow. Specifically, using such an alloy avoids problems resulting from a narrow solid-liquid coexistence region. Namely, the alloy during energizing and temperature rise is instantly changed from solid to liquid, which causes an arc to be generated easily during operation. The resulting local and sudden temperature rise causes vaporization of the flux and raises the internal pressure or chars the flux. In addition, the molten alloy or the charred flux is intensely scattered. Due to these occurrences, physical destruction, such as crack generation due to local and sudden internal pressure rise, or reconnection between charred flux portions, easily occurs during operation. Insulation distance is thus shortened and dielectric breakdown results. The wide solid-liquid coexistence region which is exhibited by the present invention will eliminate these undesirable characteristics.

The concentration of In in the present alloy, 55-74% is removed from the binary eutectic curve (47-50%) by at least 5% and as much as 27%, which makes the solid-liquid coexistence region as wide as 16°C. That is, the In range in the presently claimed alloy, which the Examiner contends to be "close" to the In ranges of JP '130 and JP '229, is actually not close at all, because the In ranges of JP '130 and JP '229 place the alloys on or in the vicinity of the binary eutectic curve, while the In range of the claimed alloy places it far removed from the binary eutectic curve.

When, as in JP '130 and JP '229, alloy compositions are set in the peripheral region of the binary eutectic curve, the solid-liquid coexistence region is narrow, and dispersion of the operating temperature is suppressed. However, as with the alloy of JP '724, these prior art alloys cannot avoid the problems which inevitably occur when the solid-liquid coexistence region is narrow, such as the physical destruction described above.

Therefore, despite the fact that the Bi and Sn concentrations in the claimed alloy composition overlap with those taught by JP '130 and '229, the ternary alloy compositions are in fact dramatically different in properties due in part to the proximity of the JP '130 and JP '229 alloys to the binary eutectic curve and the separation of the claimed alloy composition from this curve. Alloy compositions such as those taught by JP '130 and JP '229, which fall on or near the binary eutectic curve, do not exhibit the unexpected properties of the claimed alloy fuses: a narrow operating temperature range and excellent overload and dielectric breakdown

Application No. 10/656,580  
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characteristics. Accordingly, the concentrations of the alloy components, and particularly of In, are indeed critical to the present invention, and the present invention would not have been obvious to one skilled in the art based on JP '130 or JP '229, and reconsideration and withdrawal of the § 103(a) rejections are respectfully requested.

Based on the preceding Remarks, Applicants respectfully submit that the pending claims are patentably distinct from the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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Attachments: Appendix 1

Terminal Disclaimer and Statement of Common Ownership  
English Translations of JP 3-236130 and JP 59-8229